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Waugh

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(54) **NON-METALLIC FLUID COUPLING ASSEMBLIES**

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CPC F16L 25/01; F16L 25/02; F16L 25/025
USPC 285/365, 366, 367, 411, 21.2; 361/215; 219/535, 524
See application file for complete search history.

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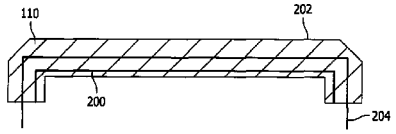
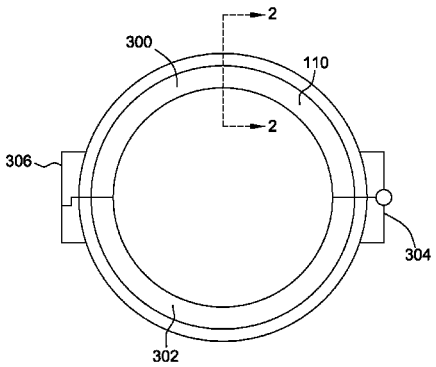
(57) **ABSTRACT**

A non-metallic coupling for coupling a first fluid conduit to a second fluid conduit includes a sealing sleeve configured for a fluid tight sealing engagement of the first fluid conduit to the second fluid conduit. A coupling member is configured to apply a sealing force to the sealing sleeve. The coupling member includes a first portion and a second portion hingedly connected to the first portion. A latch is configured to lock the first portion to the second portion.

20 Claims, 4 Drawing Sheets





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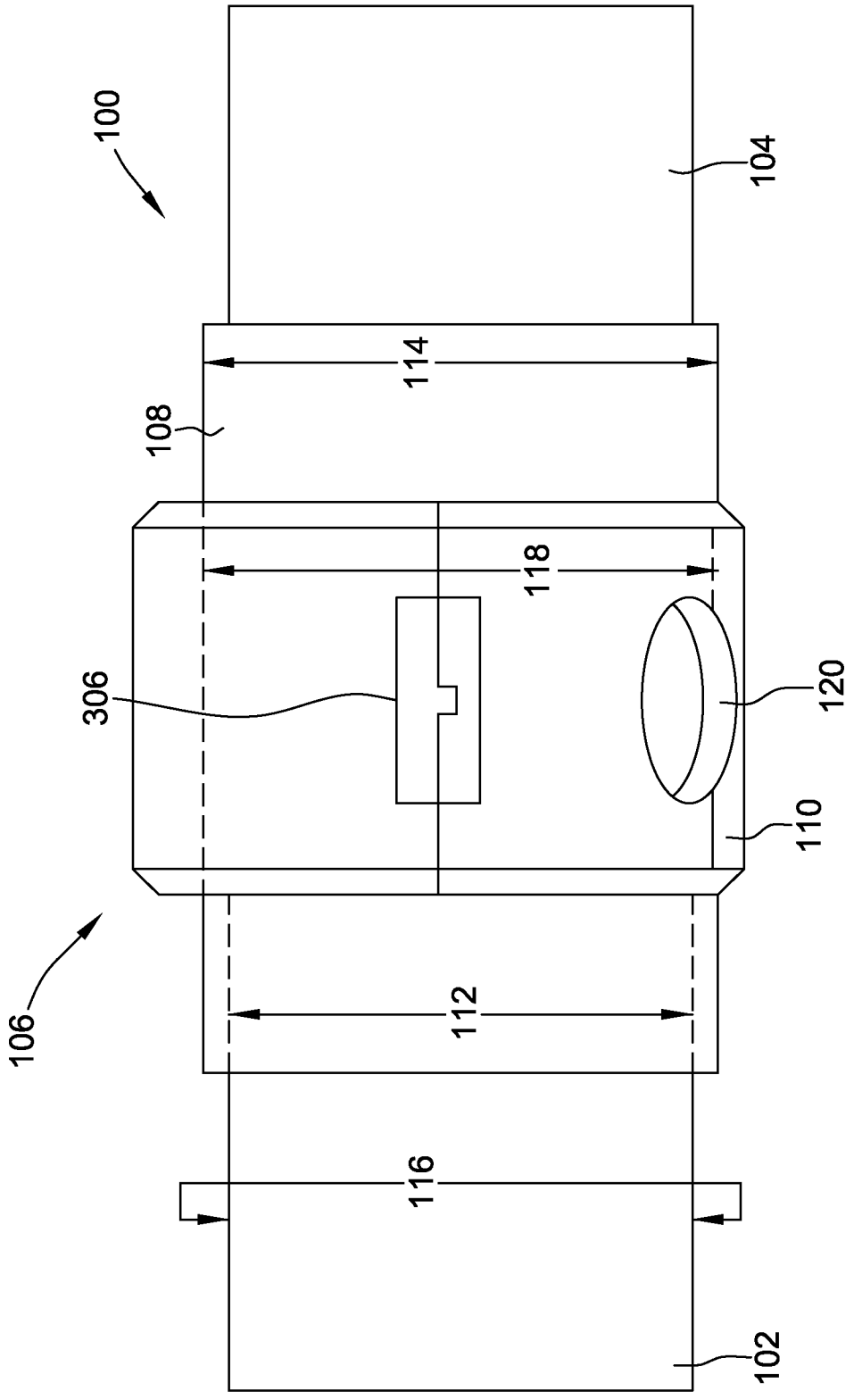

FIG. 1

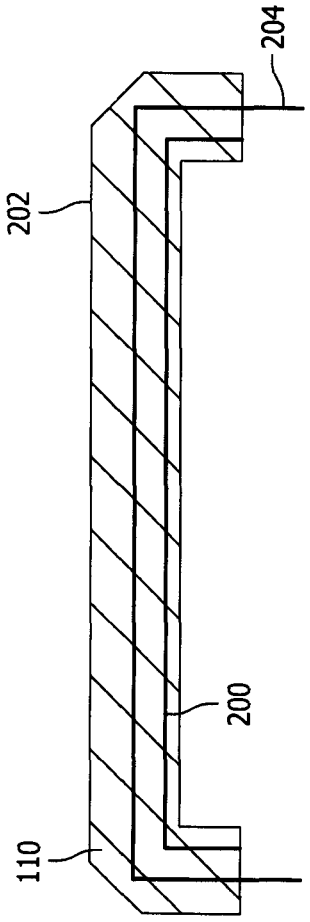

FIG. 2

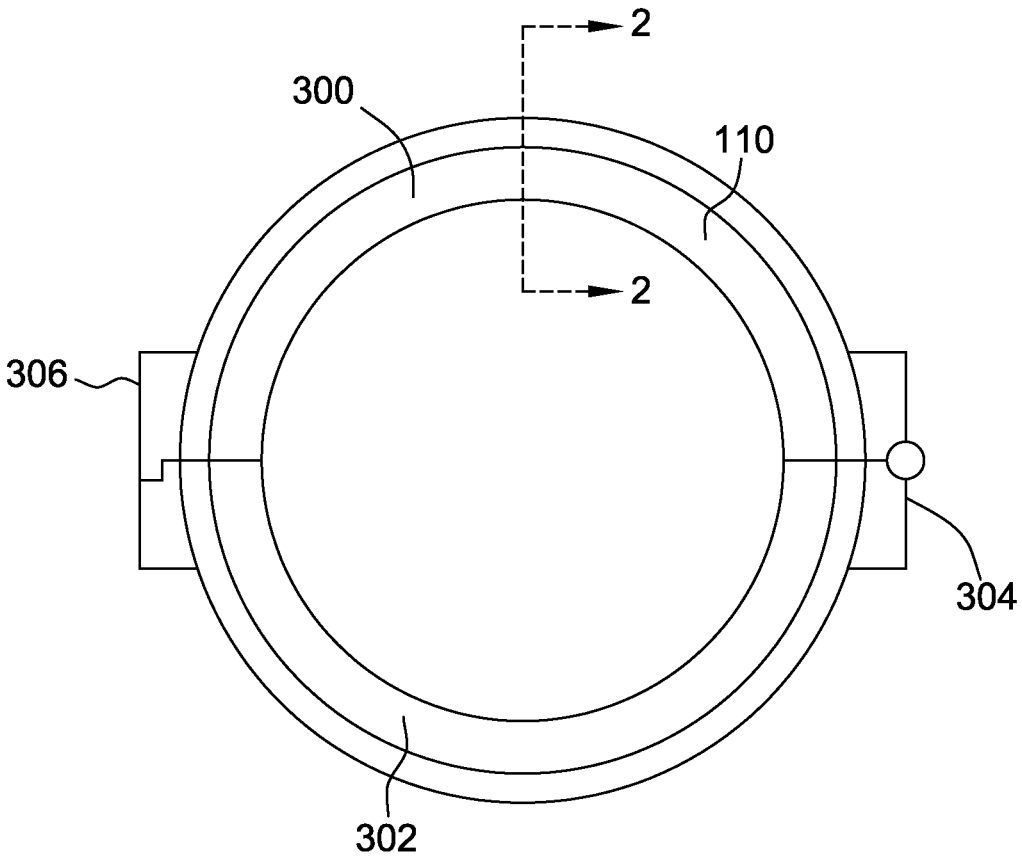

FIG. 3

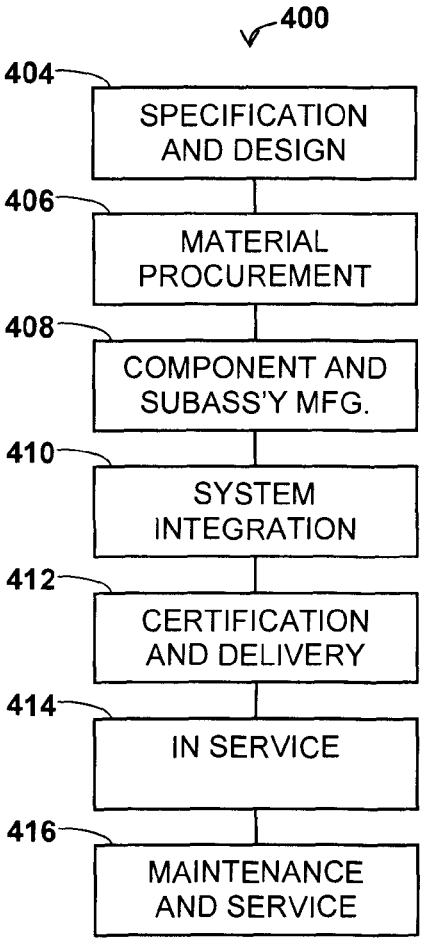
400
404
SPECIFICATION AND DESIGN
406
MATERIAL PROCUREMENT
408
COMPONENT AND SUBASS'Y MFG.
410
SYSTEM INTEGRATION
412
CERTIFICATION AND DELIVERY
414
IN SERVICE
416
MAINTENANCE AND SERVICE

FIG. 4

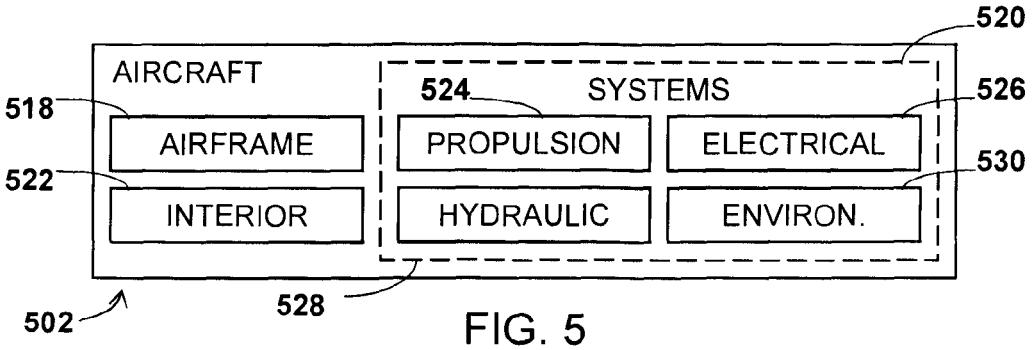
520
AIRCRAFT
524
SYSTEMS
526
518
AIRFRAME
PROPULSION
ELECTRICAL
530
522
INTERIOR
HYDRAULIC
ENVIRON.
502
528

FIG. 5

NON-METALLIC FLUID COUPLING ASSEMBLIES

BACKGROUND

The field of the disclosure relates generally to couplings for fluid connections, and more particularly to non-metallic coupling assemblies for fluid connections.

Typically, fluid couplings for mechanical systems of vehicles, such as aircraft, are fabricated from metal or metal alloys. Such metallic parts are relatively heavy and may increase the likelihood of corrosion of other parts in contact with the metallic couplings, such as by bimetallic (i.e., galvanic) corrosion. Such metallic parts may also negatively impact a lighting protection and isolation scheme on an aircraft.

BRIEF DESCRIPTION

In one aspect, a non-metallic coupling for coupling a first fluid conduit to a second fluid conduit includes a sealing sleeve configured for a fluid tight sealing engagement of the first fluid conduit to the second fluid conduit. A coupling member is configured to apply a sealing force to the sealing sleeve. The coupling member includes a first portion and a second portion hingedly connected to the first portion. A latch is configured to lock the first portion to the second portion.

In another aspect, a fluid-tight coupling for connecting two or more conduits includes a flexible sealing sleeve having an inner diameter substantially equal to an outer diameter of the two or more conduits and a bifurcated coupling member. The bifurcated coupling member includes a non-metallic first half member and a non-metallic second half member coupled to the first half member at a first location by a hinge and a latch configured to releasably retain the first half member to the second half member at a second location. An inner diameter of the first half member and an inner diameter of the second half member are substantially equal to an outer diameter of the flexible sealing sleeve.

In yet another aspect, a fluid delivery system for an aircraft includes a first fluid conduit and a second fluid conduit configured to be in communication with a fluid source. A non-metallic coupling couples the first fluid conduit to the second fluid conduit. The non-metallic coupling includes a flexible sealing member configured for sealing contact between the first fluid conduit and the second fluid conduit and a hinged coupling member received over the flexible sealing member and configured to apply a force to the flexible sealing member. A latch is configured to releasably retain the hinged coupling member over the flexible sealing member.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is shows a fluid delivery system of an implementation.

FIG. **2** is a section view of the exemplary coupling member shown in FIG. **1**.

FIG. **3** is a side view of the exemplary coupling member shown in FIG. **1**.

FIG. **4** is a flow diagram of aircraft production and service methodology.

FIG. **5** is a block diagram of an aircraft.

DETAILED DESCRIPTION

Exemplary implementations of the disclosure are described herein with reference to the figures. Accordingly, unless otherwise indicated, like reference numerals refer to like components in the figures.

FIG. **1** shows generally a fluid delivery system **100** of an implementation. The exemplary implementation includes a first fluid delivery conduit **102**, a second fluid delivery conduit **104** and a non-metallic coupling assembly **106**. Fluid conduits **102** and **104** may be a tube, pipe, vessel and the like. Such fluid delivery system may be for vehicle fluid systems including, but not limited to fuel systems, cooling systems, pneumatic systems, electronics cooling systems and the like. In some implementations, the fluid delivery system is a fluid delivery system of an aircraft.

In one implementation, each of first fluid delivery conduit **102** and second fluid delivery conduit **104** are substantially cylindrical. In other implementations, fluid delivery conduits **102** and **104** may be any shape that allows the systems to function as described herein. Each of fluid delivery conduits **102** and **104** have an inside diameter **112** and an outside diameter **114** that is larger than the inside diameter. Fluid delivery conduits **102** and **104** are sized appropriately by one of ordinary skill depending upon the particular application for which the fluid delivery system is used. Fluid delivery conduits **102** and **104** are separate components and require coupling together in order to allow fluid to pass therethrough and maintain a seal against fluid leaks at the coupling. In order to couple first fluid conduit **102** to second fluid conduit **104**, a coupling assembly **106** is provided.

Coupling assembly **106** includes a sealing member **108** and a coupling member **110**. In one implementation, sealing member **108** is fabricated from a flexible material, such as rubber, plastic, polymers, textiles, resin impregnated fabrics and the like, which may be electrically insulative or isolative. In other implementations, flexibility to sealing member **108** may be imparted by way of the shape of sealing member **108**, rather than material alone. In any instance, such flexibility is configured to allow at least some movement between fluid conduits **102** and **104**. In some implementations, sealing member **108** is a sealing chamber with a piston seal or fay surface seal. Sealing member **108**, also referred to herein as a sealing "sleeve," is configured to have an inner cross section shape, or diameter, that is complimentary to the outer cross sectional shape of fluid delivery conduits **102** and **104**. For example, if fluid delivery conduits **102** and **104** are substantially cylindrical shapes (i.e., with a circular cross section), then the inner cross sectional shape of sealing member **108** has a circular cross sectional shape. However, conduits **102** and **104** and sealing member **108** may be any shape that allows the fluid coupling assemblies to function as described herein. The inner diameter **112** of the sealing member **108** is substantially the same as, or slightly larger than, the outer diameter **116** of fluid delivery conduits **102** and **104**. As such, the inside surface of sealing member **108** fits tightly against the outside surface of fluid delivery conduits **102** and **104**. In one implementation, sealing member **108** is configured to seal directly against fluid delivery conduits **102** and **104**. In other implementations, one or more adhesives or sealants (not shown) may be applied between sealing member **108** and the outer surface of fluid delivery conduits **102** and **104**.

Coupling member **110** is configured to receive sealing member **108** and fluid conduits **102** and **104** therein. In the exemplary implementation, the inner diameter **118** of coupling member **110** is sized such that it fits tightly against sealing member **108** when sealing member **108** is placed within coupling member **110**. In some implementations, coupling member **110** includes one or more orifices **120** that provide viewing of the sealing member **108** therein, for

inspection purposes, reduced weight and the like. In other implementations, coupling member **110** includes no orifices.

Reference is now made to FIGS. **2** and **3**. Shown in FIG. **2** is a partial section view of coupling member **110** taken along section line **2-2** of FIG. **3**. In the exemplary implementation, coupling member **110** has a C-shaped cross section, but may be any shape that allows the coupling member to function as described herein. In one implementation, coupling member **110** is fabricated from a non-metallic material, such as plastic, composites, polymers such as PEEK, fiberglass and the like or combinations thereof. Such non-metallic materials may be electrically conductive or insulative (i.e., having a high electrical resistance). In some implementations, at least a portion of coupling member **110** is fabricated from a non-metallic insulative material. In other implementations, at least a portion of coupling member **110** is fabricated from a conductive non-metallic material. In other implementations, the entire coupling member **110** is fabricated from an electrically insulative material. Coupling member **110** includes an inner surface **200** and an outer surface **202**. In one implementation, coupling member **110** includes an electrically conductive member **204**, also referred to as a "bonding member." The electrically conductive member **204** is fabricated from a material that is electrically conductive, such as carbon black, metal, metal alloys, a conductive non-metallic material and the like. In the exemplary implementation, electrically conductive member **204** is disposed between inner surface **200** and outer surface **202** of coupling member **110**. However, in other implementations, electrically conductive member may also be disposed on outer surface **202** or inner surface **200**. Electrically conductive member **204** may be configured to conduct electricity between fluid conduits **102** and **104** (shown in FIG. **1**).

As shown in FIG. **3**, coupling member **110** includes a first portion **300** and a second portion **302**. First portion **300** is connected to second portion **302** via a hinge member **304**. As such, coupling member **110** is bifurcated and may open and close like a "clam-shell." In one implementation, first portion **300** and second portion **302** are semi-circular in cross-sectional shape and each corresponds to substantially half of the coupling member **110**. In other implementations, each of first portion **300** and second portion **302** are different sizes, such that the total cross section of both encompasses substantially 360 degrees (i.e., a complete perimeter without a substantial gap). Hinge member **304** may be a living hinge, barrel hinge and the like. Hinge member **304** may be formed integrally with one or more of first portion **300** and second portion **302**, and in other implementations hinge member **304** may be separately formed and mechanically fastened to first portion **300** and second portion **302**. A latch member **306** releasably retains first portion **300** and second portion **302** in a closed (i.e., clamped) state, for example as shown in FIG. **3**. When in the closed state, coupling member **110** is configured to apply a radial force to sealing member **108** such that sealing member **108** seals against fluid conduits **102** and **104**, thus creating a fluid tight seal. In one implementation, coupling assembly **100** is fluid-tight at a pressure up to 200 pounds per square inch, more particularly between about 25 to 175 psi, 50 psi to 150 psi, or 75 psi to 125 psi. For installation or disconnection purposes, latch **306** may be released to place first portion **300** and second portion **302** in an open state, such that little or no radial pressure is applied to sealing member **108**. It is noted that latch **306** may be any retaining device that allows the fluid coupling assemblies to function as described herein. In one implementation, one or more of first portion **300** and second portion **302** are configured to receive an O-ring or piston seal (not shown) to provide additional sealing between fluid conduits **102** and **104**.

Fabrication of one or more components of coupling assembly **100** may be by way of casting, forging, composite lay-up, resin transfer molding, stereo lithography and the like or combinations thereof. The materials described herein for fabrication of one or more components of coupling assembly **100** may be used for any of the components described herein. In one implementation, the components are fabricated such that the electrical conductivity of the sealing member **108** is different than the electrical conductivity of the coupling member **110**. As the coupling assemblies are non-metallic or substantially non-metallic, lightweight assemblies may be fabricated that weigh up to 25% less than traditional coupling assemblies.

With reference to FIGS. **4** and **5**, implementations of this disclosure may be described in the context of an aircraft manufacturing and service method **400** as shown in FIG. **4** and an aircraft **502** as shown in FIG. **5**. During pre-production, exemplary method **400** may include specification and design **404** of the aircraft **502** and material procurement **406**. During production, component and subassembly manufacturing **408** and system integration **410** of the aircraft **502** takes place. Thereafter, the aircraft **502** may go through certification and delivery **412** in order to be placed in service **414**. While in service by a customer, the aircraft **502** is scheduled for routine maintenance and service **416** (which may also include modification, reconfiguration, refurbishment, and so on).

Each of the processes of method **400** may be performed or carried out by a system integrator, a third party, and/or an operator (e.g., a customer). For the purposes of this description, a system integrator may include without limitation any number of aircraft manufacturers and major-system subcontractors; a third party may include without limitation any number of venders, subcontractors, and suppliers; and an operator may be an airline, leasing company, military entity, service organization, and so on.

As shown in FIG. **5**, the aircraft **502** produced by exemplary method **400** may include an airframe **518** with a plurality of systems **520** and an interior **522**. Examples of high-level systems **520** include one or more of a propulsion system **524**, an electrical system **526**, a hydraulic system **526**, and an environmental system **530**. Any number of other systems may be included. Although an aerospace example is shown, the principles of the invention may be applied to other industries, such as the automotive industry.

Apparatus and methods embodied herein may be employed during any one or more of the stages of the production and service method **100**. For example, components or subassemblies corresponding to production process **108** may be fabricated or manufactured in a manner similar to components or subassemblies produced while the aircraft **502** is in service. Also, one or more apparatus embodiments, method embodiments, or a combination thereof may be utilized during the production stages **408** and **410**, for example, by substantially expediting assembly of or reducing the cost of an aircraft **502**. Similarly, one or more of apparatus embodiments, method embodiments, or a combination thereof may be utilized while the aircraft **502** is in service, for example and without limitation, to maintenance and service **416**.

Exemplary implementations of the coupling assembly are described above in detail. The coupling assembly and its components are not limited to the specific implementations described herein, but rather, components of the systems may be utilized independently and separately from other compo-

nents described herein. For example, the components may also be used in combination with other fluid systems, methods, and apparatuses, and are not limited to practice with only the systems and apparatus as described herein. Rather, the exemplary implementations can be implemented and utilized in connection with many other applications.

Although specific features of various implementations of the disclosure may be shown in some drawings and not in others, this is for convenience only. In accordance with the principles of the disclosure, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

This written description uses examples to disclose various implementations, including the best mode, and also to enable any person skilled in the art to practice the aspects of the disclosure, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the disclosure is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A non-metallic coupling for coupling a first fluid conduit to a second fluid conduit, the non-metallic coupling comprising:

a sealing sleeve configured for a fluid tight sealing engagement of the first fluid conduit to the second fluid conduit;

a coupling member configured to apply a sealing force to the sealing sleeve, the coupling member comprising:

a first portion and a second portion hingedly connected to the first portion, the first portion and the second portion each having an inner surface and an outer surface;

a latch configured to lock the first portion to the second portion; and

an electrically conductive member positioned between the inner surface and the outer surface such that the electrically conductive member is substantially embedded within at least one of the first portion and the second portion, the electrically conductive member configured to electrically couple the first fluid conduit to the second fluid conduit, wherein the electrically conductive member includes a first end and an opposing second end, the first end extending from one of the first portion and the second portion to contact the first fluid conduit, and the second end extending from one of the first portion and the second portion to contact the second fluid conduit.

2. The non-metallic coupling according to claim **1**, wherein the coupling member has a substantially cylindrical shape.

3. The non-metallic coupling according to claim **2**, wherein the first portion is substantially half of a cylinder and the second portion is substantially another half of the cylinder.

4. The non-metallic coupling according to claim **1**, wherein at least one of the sleeve and the coupling member are fabricated from a plastic material.

5. The non-metallic coupling according to claim **1**, wherein at least one of the sleeve and the coupling member are fabricated from a composite material.

6. The non-metallic coupling according to claim **1**, wherein the electrically conductive member is fabricated from carbon black.

7. The non-metallic coupling according to claim **1**, wherein the coupling member further comprises an electrically isolative member configured for electrical isolation between the first fluid conduit and the second fluid conduit.

8. The non-metallic coupling according to claim **1**, wherein the coupling member is fabricated from an electrically insulative material.

9. The non-metallic coupling according to claim **1**, wherein the electrical conductivity of the sealing sleeve is different than the electrical conductivity of the coupling member.

10. The non-metallic coupling according to claim **1**, wherein the sealing sleeve is flexible.

11. The non-metallic coupling according to claim **1**, wherein the sealing sleeve spans a joint formed between the first fluid conduit and the second fluid conduit.

12. The non-metallic coupling according to claim **1**, wherein the sealing sleeve comprises a first axial length and the coupling member includes a second axial length that is shorter than the first axial length.

13. The non-metallic coupling according to claim **1**, wherein the electrically conductive member is positioned circumferentially between the latch and the hinged connection of the first fluid conduit and the second fluid conduit.

14. A fluid-tight coupling for connecting two or more conduits, the fluid-tight coupling comprising:

a flexible sealing sleeve having an inner diameter substantially equal to an outer diameter of the two or more conduits; and

a bifurcated coupling member comprising:

a non-metallic first half member and a non-metallic second half member coupled to the first half member at a first location by a hinge, the first half member and the second half member each having an inner surface and an outer surface;

a latch configured to releasably retain the first half member to the second half member at a second location; and

an electrically conductive member positioned between the inner surface and the outer surface such that the electrically conductive member is substantially embedded within at least one of the first half member and the second half member, the electrically conductive member configured to electrically couple the first fluid conduit to the second fluid conduit, wherein the electrically conductive member includes a first end and an opposing second end, the first end extending from one of the first portion and the second portion to contact the first fluid conduit, and the second end extending from one of the first portion and the second portion to contact the second fluid conduit;

wherein an inner diameter of the first half member and an inner diameter of the second half member are substantially equal to an outer diameter of the flexible sealing sleeve.

15. The fluid-tight coupling according to claim **14**, wherein the bifurcated coupling member is configured to apply a substantially radial pressure to the flexible sealing sleeve when the first half member is retained to the second half member.

16. The fluid-tight coupling according to claim **14**, wherein the fluid-tight coupling is configured to be fluid-tight at a pressure up to 200 pounds per square inch.

17. The fluid-tight coupling according to claim **14**, wherein the bifurcated coupling member is fabricated from at least one of a composite material, a polymer or a plastic.

18. A fluid delivery system for an aircraft, comprising:

a first fluid conduit and a second fluid conduit configured to be in communication with a fluid source; and

a non-metallic coupling for coupling the first fluid conduit to the second fluid conduit, the non-metallic coupling comprising:

a flexible sealing member configured for sealing contact between the first fluid conduit and the second fluid conduit;

a hinged coupling member received over the flexible sealing member and configured to apply a force to the flexible sealing member, the coupling member having an inner surface and an outer surface;

a latch configured to releasably retain the hinged coupling member over the flexible sealing member; and

an electrically conductive member positioned between the inner surface and the outer surface such that the electrically conductive member is substantially embedded within the coupling member, the electrically conductive member configured to electrically couple the first fluid conduit to the second fluid conduit, wherein the electrically conductive member includes a first end and an opposing second end, the first end extending from one of the first portion and the second portion to contact the first fluid conduit, and the second end extending from one of the first portion and the second portion to contact the second fluid conduit.

19. The fluid delivery system according to claim **18**, wherein the non-metallic coupling is fabricated from an electrically non-conductive material.

20. The fluid delivery system according to claim **18**, wherein the non-metallic coupling is fabricated from a composite material.

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